

Elastomeric Sensing of Pressure with Liquid Metal and Wireless Inductive Coupling

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This project describes resistance-based soft sensors filled with liquid metal, which permit measurements of large strains (0% to 110%), associated with small forces of less than 30 Newtons. This work also demonstrates a methodology for wireless transfer of these strain measurements without connected electrodes. These sensors allow intermittent detection of pressure on soft membranes with low force. Adapting these sensors for passive wireless pressure sensing will eliminate the need for embedded batteries, and will allow the sensors to transmit pressure data through non-conductive materials including glass and acrylic. The absence of batteries allows us to embed these sensors into materials for long-term use because the sensors only use passive analog circuit elements. We found the oxidation of the liquid metal (eutectic gallium indium) plays a role in the repeatability of the soft sensors. We investigated how the oxidation layer affected the behavior of the sensor by encapsulating materials (silicone, fluorosilicone, and PVC) with varied permeabilities to oxygen. We measured the effects of mechanical loading on the oxidation layer and the effects of wireless inductive coupling on the oxidation layer. We concluded our research by investigating the effects of embedding self-resonant circuits into PDMS.

Efforts to design engineered systems with soft materials are growing field with progress in soft robotics, epidermal electronics, and wearable electronics. In the field of soft robotics, polydimethylsiloxane (PDMS)-based grippers are capable of picking up delicate objects because their form-fitting properties allow them to conform to the shape of objects more easily than conventional robotic grippers.^[1,2] Epidermal devices also use PDMS as a substrate to hold electronic components such as radios, sensors, and power supply circuits.^[3–5] Additionally, PDMS-based soft sensors can monitor human motion with liquid metal embedded within micro-channels.^[6] Passive wireless sensors have applications in structural health monitoring and medical health monitoring. Doctors can take wireless blood pressure measurements inside arteries to monitor the progression of heart disease.^[7] Glaucoma patients can use this technology to monitor the pressure in their eyes to track the progression of the disease.^[8]

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